# CHAPTER 1

# OPERATIONAL PROCEDURES

A. GENERAL

Services provided by the Joint Typhoon Warning Center (JTWC) include forecasts of tropical cyclone formation, intensity, direction and speed of movement and areal extent of damaging winds. The primary products of JTWC providing these services are the Tropical Cyclone Formation Alert issued when formation of a tropical cyclone is suspect, and tropical cyclone warnings issued in 1970 at 0500Z plus every six hours whenever tropical cyclones existed in the JTWC area.

FLEWEACEN Guam provides computer and meteorological/oceanographic analysis support for JTWC.

Communications services for JTWC are provided by the Nimitz Hill Message Center of NAVCOMMSTA Guam.

Prior to the 1970 typhoon season the Fleet Weather Central Guam Communications Center was consolidated with the larger Nimitz Hill Message Center. This caused many excessive delays in JTWC's outgoing traffic (primarily warnings, alerts, etc.) during the first few storms of the season. However after much effort on the part of the Nimitz Hill Message Center staff and the Operations Department of Fleet Weather Central Guam, excessive delays were greatly reduced by October 1970. The use of FLASH precedence on all warnings to U. S. forces afloat virtually eliminated excessive delays to these customers.

B. ANALYSES AND DATA SOURCES

1. FWC ANALYSES:

a. Surface polar stereographic projection analysis, Northern Hemisphere, Western Pacific area; 0000Z, 0600Z, 1200Z, and 1800Z.

b. Surface micro-analysis of South China Sea region; 0000Z, 0600Z, 1200Z, and 1800Z.

c. Surface mercator projection analysis, Northern and Southern Hemisphere, Western Pacific and Indian Ocean area; 0600Z and 1800Z.

d. Sea surface temperature charts; daily.

2. JTWC ANALYSES:

a. Gradient level (3,000 feet) streamline analysis and nephanalysis of satellite-observed significant cloudiness; 0000Z and 1200Z.

b. 700 mb, 500 mb, and 200 mb mercator projection contour analysis; 0000Z and 1200Z.

c. Reconnaissance data. Observations from weather reconnaissance aircraft are plotted on large scale sectional charts.

d. Time cross sections of selected tropical stations.

e. Time sections of surface reports for selected tropical stations.

f. Additional and more frequent analyses similar to those above during periods of tropical cyclone activity.

3. SATELLITE DATA:

The quantity and quality of satellite data continued to increase during the 1970 typhoon season. ESSA-8 continued to be the primary source of satellite data during the morning hours. These data were interspersed with NIMBUS III satellite passes. In February 1970 the first ITOS satellite became operational providing afternoon satellite coverage, and in December 1970 the second of the ITOS series was launched giving additional afternoon coverage.

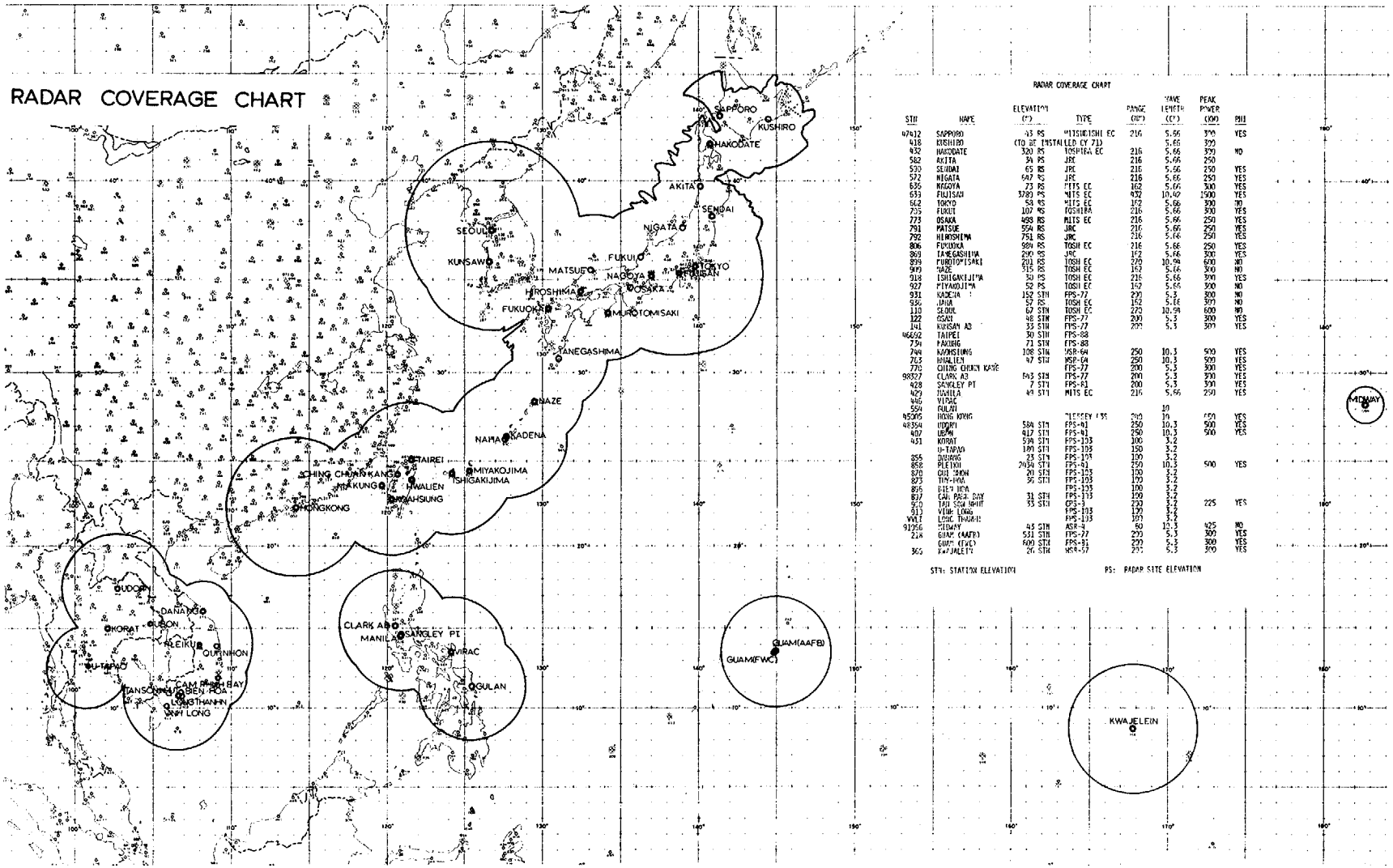
During the night both ITOS-1 and NIMBUS III IR coverage was received until 25 September when the NIMBUS equipment failed. Only the center portion of a DRIR pass gives an undistorted view of cloud patterns, therefore there is a significant gap between each sub-orbital track which is not viewed clearly. The chance of a disturbance being within the undistorted portion of the satellite's swath was significantly reduced when the NIMBUS III equipment failed. The IR passes were also used for briefing reconnaissance crews making early morning investigative flights into tropical disturbances.

Excellent satellite coverage was received between 120°E and 160°E using Fleet Weather Central Guam's APT equipment. Fleet Weather Central Pearl Harbor furnished live APT coverage for area east of 160°E via dedicated landline. Sparse coverage of the area west of 120°E was furnished by Clark AFB by means of a taped pass relayed over AUTOVON. Unfortunately the poor quality of the taped data reduced its usefulness.

4. RADAR:

Land radar reports, when available, were used for tracking tropical cyclones during the 1970 typhoon season. Once a storm moved within range of a land radar site, reports were usually received hourly.

Figure 1-1 shows the network of land radar stations in the Western Pacific and Southeast Asia. Most of the major




RADAR COVERAGE CHART

| STN | NAME | ELEVATION (FT) | TYPE | RANGE (NM) | WAVE LENGTH (CM) | PEAK POWER (KW) | PHI |
|---|---|---|---|---|---|---|---|
| 47412 | SAPPORO | 43 RS | MITSUBISHI EC | 216 | 5.66 | 300 | YES |
| 418 | KUSHIRO | (TO BE INSTALLED CY 71) | | | 5.66 | 300 | |
| 432 | HAKODATE | 320 RS | TOSHIBA EC | 216 | 5.66 | 300 | NO |
| 582 | AKITA | 34 RS | JRC | 216 | 5.66 | 250 | |
| 590 | SENDAI | 69 RS | JRC | 216 | 5.66 | 250 | |
| 572 | NIIGATA | 647 RS | JRC | 216 | 5.66 | 250 | YES |
| 636 | NAGOYA | 23 RS | MITS EC | 162 | 5.66 | 300 | YES |
| 633 | FUJISAN | 3781 RS | MITS EC | 432 | 10.42 | 1500 | YES |
| 662 | TOKYO | 58 RS | MITS EC | 162 | 5.66 | 300 | NO |
| 735 | FUKUI | 107 RS | TOSHIBA | 216 | 5.66 | 300 | YES |
| 773 | OSAKA | 498 RS | MITS EC | 216 | 5.66 | 250 | YES |
| 791 | MATSUE | 554 RS | JRC | 216 | 5.66 | 250 | YES |
| 792 | HIROSHIMA | 751 RS | JRC | 216 | 5.66 | 250 | YES |
| 806 | FUKUOKA | 984 RS | TOSH EC | 216 | 5.66 | 250 | YES |
| 869 | TANEGASHIMA | 290 RS | JRC | 162 | 5.66 | 300 | YES |
| 899 | MUROTOMISAKI | 201 RS | TOSH EC | 270 | 10.96 | 600 | NO |
| 909 | NAZE | 515 RS | TOSH EC | 162 | 5.66 | 300 | NO |
| 918 | ISHIGAKEJIMA | 30 RS | TOSH EC | 216 | 5.66 | 300 | YES |
| 927 | MIYAKOJIMA | 52 RS | TOSH EC | 162 | 5.66 | 300 | NO |
| 931 | KADENA | 152 STN | FPS-77 | 200 | 5.3 | 300 | NO |
| 936 | JAPAN | 57 RS | TOSH EC | 162 | 5.66 | 300 | NO |
| 110 | SEOUL | 67 STN | TOSH EC | 270 | 10.96 | 600 | NO |
| 122 | OSAN | 48 STN | FPS-77 | 200 | 5.3 | 300 | YES |
| 141 | KUNSAN AB | 33 STN | FPS-77 | 200 | 5.3 | 300 | YES |
| 46692 | TAIPEI | 30 STN | FPS-88 | | | | |
| 734 | MAKUNG | 71 STN | FPS-88 | | | | |
| 744 | KAOHSIUNG | 108 STN | ASR-64 | 250 | 10.3 | 500 | YES |
| 753 | HUALIEN | 47 STN | MSR-64 | 250 | 10.3 | 500 | YES |
| 770 | CHUNG CHUNG KANG | | FPS-77 | 200 | 5.3 | 300 | YES |
| 98327 | CLARK AB | 645 STN | FPS-77 | 200 | 5.3 | 300 | YES |
| 428 | SUBLEY PT | 7 STN | FPS-81 | 200 | 5.3 | 300 | YES |
| 429 | MANILA | 49 STN | MITS EC | 216 | 5.66 | 250 | YES |
| 446 | VIRAC | | | | | | |
| 554 | GULAN | | | | 10 | | |
| 45005 | HONG KONG | | TELSEEV (?) | 200 | 10 | 450 | YES |
| 48354 | UDORN | 584 STN | FPS-81 | 250 | 10.3 | 500 | YES |
| 407 | UBON | 417 STN | FPS-81 | 250 | 10.3 | 500 | YES |
| 451 | KORAT | 594 STN | FPS-103 | 100 | 3.2 | | |
| | U-TAPAO | 189 STN | FPS-103 | 150 | 3.2 | | |
| 356 | DANANG | 23 STN | FPS-109 | 100 | 3.2 | | |
| 858 | PLEIKU | 2034 STN | FPS-81 | 250 | 10.3 | 500 | YES |
| 870 | QUI NHON | 20 STN | FPS-103 | 100 | 3.2 | | |
| 873 | TAN-HOA | 36 STN | FPS-103 | 100 | 3.2 | | |
| 896 | BIEN HOA | | FPS-103 | 100 | 3.2 | | |
| 897 | CAM RANH BAY | 31 STN | FPS-109 | 100 | 3.2 | | |
| 900 | TAN SON NHUT | 33 STN | GPS-3 | 200 | 3.2 | 225 | YES |
| 913 | VINH LONG | | FPS-103 | 100 | 3.2 | | |
| WHT | LONG THANH | | FPS-103 | 100 | 3.2 | | |
| 91356 | MIDWAY | 45 STN | ASR-4 | 60 | 10.3 | 425 | NO |
| 216 | GUAM (AAFB) | 531 STN | FPS-77 | 200 | 5.3 | 300 | YES |
| | GUAM (FWC) | 699 STN | FPS-81 | 200 | 5.3 | 300 | YES |
| 365 | KWAJALEIN | 20 STN | MSR-59 | 200 | 5.3 | 300 | YES |

STN: STATION ELEVATION  RS: RADAR SITE ELEVATION



FIGURE 1-1

population centers have excellent radar coverage, especially in Japan. Pertinent data for most stations are included in the insert. Japan's Mt. Fuji radar has the greatest range due to its high elevation and extreme power. An example of the radar presentation from the Mt. Fuji site is given in Chapter 5 (Typhoon Clara).

5. COMPUTER PRODUCTS, 0000Z and 1200Z:

a. Hemispheric analyses and barotropic prognoses for 1000 mb, 700 mb, 500 mb, 300 mb, and 200 mb. (Replaced by Primative Equation model Progs in mid 1970).

b. Decomposition fields of the 500 mb (SD, SR and SL) analyses and prognoses. The SD, SR, and SL fields correspond roughly to small scale disturbances, mean flow and long wave pattern respectively.

c. Computer analysis of tropical streamlines for the 700-, 500-, 400-, 300-, 250-, and 200-mb levels from FWC Pearl fields were used in 1970.

d. The HATRACK typhoon steering program based on SR prognostic fields was used on an operational time basis as a forecast aid.

e. The TYRACK typhoon steering program was operationally used during the 1970 season. This program utilizes the FWC Pearl tropical streamline fields for determining forecast movement.

f. In an effort to aid in assessment of development potential, tropospheric vertical shear charts based on FWC Pearl streamline fields were produced twice daily throughout most of the 1970 season along with similarly derived 250 mb and 700 mb divergence charts for the Western Pacific. Vertical shear-values were computed by vector subtraction of the 700 mb wind from a mean of the 400 mb, 300 mb, 250 mb, and 200 mb winds.

g. The TYFOON analog climatological program was first used in 1970 beginning with Typhoon Wilda (August). This program was developed under NAVWEARSCHFAC sponsorship by the National Weather Records Center, and extensively modified at NAVWEARSCHFAC.

C. FORECAST AIDS

1. CLIMATOLOGY:

The following climatological publications were utilized:

a. Tropical Cyclones in the Western Pacific and China Sea Area (Royal Observatory, Hong Kong), covering 70 years of typhoon tracks.

b. Climatological Aid to Forecasting Typhoon Movement (1st Weather Wing).

c. Climatological 24-Hour Typhoon Movement (McCabe, J. T., 1961).

d. Western Pacific Typhoon Tracks, 1950-1959 (FWC/JTWC).

e. Far East Climate Atlas (1st Weather Wing, February 1963).

f. Annual Typhoon Reports, 1959-1969 (FWC/JTWC).

g. A Climatology of Tropical Cyclones and Disturbances of the Western Pacific with a Suggested Theory for Their Genesis/Maintenance (Gray, Wm. 1970) NAVWEARSCHFAC Tech Paper No. 19-70.

2. PERSISTENCE:

Extrapolation of storm movement using 12 to 18 hour mean speed and direction was the most reliable objective method for 24 hour forecasts.

3. OBJECTIVE TECHNIQUES:

During 1969 the following individual objective forecasting methods were employed:

a. ARAKAWA - surface pressure grid model.

b. HATRACK - based on 700 mb SR prognosis.

c. HATRACK - based on 500 mb SR prognosis.

d. TYRACK - based on program-selected best steering level from Pearl tropical fields.

e. TYFOON - analog weighted mean track and best analog track.

(See Chapter 3 for technique evaluation.)

D. FORECASTING PROCEDURES:

1. TRACK FORECASTING: An initial track based on persistence blended subjectively with climatology is developed for a 3 to 4 day period. This initial track is subjectively modified by use of the following:

a. Recent steering is evaluated by considering the latest upper air analyses as representative of the average upper air flow over the past 24 hours. (The latest upper air analyses are normally about 12 hours old thus roughly represent the mid-point of the last 24 hour time interval.) By this technique actual past 24 hour movement serves to indicate the best steering level as well as the effectiveness of steering.

b. Objective techniques are considered, weight is given to techniques according to recent past performance.

c. 24 hour height change analyses and progs are used to forecast track/speed changes. (Hoover 1957).

d. The prospects of recurvature must be evaluated for all westward moving storms. The basic tools for this evaluation are accurate continuity on mid-latitude troughs and numerical progs to indicate changes in amplitude or movement. Relative position and strength of the subtropical ridge and northward beta force are also important considerations.

e. Finally a check is made against climatology to ascertain the likelihood of the forecast. If the forecast track is climatologically unusual a reappraisal of the forecast rationale is made and adjustments are made if warranted.

2. INTENSITY FORECASTING: Intensity forecasts are made by using a linear extrapolation of past intensification subjectively tempered with climatology as a first guess. This first guess is modified considering availability of upper tropospheric evacuation, 850-700 mb temperatures, sea surface temperatures, and possible terrain. All these considerations are predictions along the forecast track and thus dependent on the accuracy of the forecast positions as well as the accuracy of their evaluations.

E. WARNINGS:

Tropical cyclone warnings are numbered consecutively without regard for upgrading or downgrading of the storm between intensity stages. If warnings are discontinued and the storm again intensifies, warnings are numbered consecutively from the last warning issued. Amended or corrected warnings are

given the same number as the warnings they modify. Forecast positions are issued at 0500Z plus every six hours as follows:

| | |
|---|---|
| Tropical Depressions | 12 hr and 24 hr |
| Typhoons and Tropical Storms | 12, 24, and 48 hr (72 hr at 11Z and 23Z only) |

Forecast periods are stated with respect to warning time. Thus a 24 hour forecast verifies 26 hours after the aircraft fix data, 29 hours after the latest surface synoptic chart and 29 to 35 hours after the latest upper air charts.

Warning forecast positions are verified against the corresponding post analysis "best track" positions. A summary of results from 1970 is presented in Chapter 4.

F. PROGNOSTIC REASONING MESSAGE:

Whenever warnings are being issued, an amplifying message is issued at 00Z and 12Z. This prognostic reasoning message is intended to provide meteorological units with technical and non-technical reasoning appropriate to the behavior of current storms and the logic of the latest JTWC forecasts.

G. TROPICAL WEATHER SUMMARY:

This message is issued daily from May through December and otherwise when significant tropical cyclogenesis is forecasted or observed. It is issued at 0600Z and describes the location, intensity and likelihood of development of all tropical low pressure areas and significant cloud "blobs" detected by satellite.

H. TROPICAL CYCLONE FORMATION ALERT:

Alerts are issued when the formation of a tropical cyclone is considered possible or probable. Alerts are typically used to cover a suspect area before reconnaissance can be conducted and additionally to cover an existing tropical depression of low or unknown development potential. These messages are issued at any time, are usually valid for 24 hours unless cancelled, superseded or extended.

REFERENCE:

Hoover, E. W., Devices for Forecasting Movement of Hurricanes, Manuscript of the U. S. Weather Bureau, Jan. 1957.